Multi-modal technology for non-destructive characterization of bioengineered tissues

Grant Award Details

Multi-modal technology for non-destructive characterization of bioengineered tissues

Grant Type: Tools and Technologies III

Grant Number: RT3-07981

Project Objective: To create a multimodal imaging tool to evaluate the evolution of engineered bone and cartilage. The maturation of stem cell-based tissues will be monitored by optical imaging, to detect fluorescent signatures of extracellular matrix molecules, and ultrasonic imaging for matrix distribution and quantity. Data will be correlated with standard destructive methods to characterize changes in cell phenotype and construct mechanical qualities. To address safety and efficacy issues with patient-to-patient variability, this probe will allow for repeated quality control checks on all engineered constructs, ensuring correct neotissue maturation in vitro and phenotype retention in vivo, while reducing cost, effort, and cells needed. Moreover, this multimodal technology has immense potential to support the "personalized medicine" aspect of stem cell-based tissue generation and advance our understanding of the development and remodeling of engineered tissues.

Investigator:

Name:	J. Leach
Institution:	University of California, Davis
Type:	PI

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Name:	Laura Marcu
Institution:	University of California, Davis
Type:	Co-PI

Disease Focus: Bone or Cartilage Disease

Human Stem Cell Use: Adult Stem Cell

Award Value: $1,842,792

Status: Active

Progress Reports

Reporting Period: Year 1

View Report

Grant Application Details

Application Title: Multi-modal technology for non-destructive characterization of bioengineered tissues

Public Abstract:

Stem cell technologies hold great promise for engineering replacement tissues for repairing functional loss from trauma or disease. Such therapies are particularly important for replacing bone and cartilage in the aging population to maintain an active quality of life. However, the application of stem cells to generate individualized implantable grafts suffers from patient-to-patient variability that is unpredictable and immeasurable without destructive techniques, representing a major bottleneck in translating stem cell technologies to the clinic and delivering a quality product. This process could be markedly improved by the availability of nondestructive, non- or minimally invasive methods to measure dynamic changes in tissue development, thereby reducing the quantity of tissue collection for sufficient cell numbers and cutting costs that do not directly benefit the patient. During tissue formation, cells deposit extracellular matrix molecules that possess a unique fluorescence signature, which can be detected by light, while matrix quantity, detectable by ultrasound, correlates with mechanical strength. We propose the development and application of a multi-modal imaging probe that uses light and sound to detect changes in engineered bone and cartilage, which reflect maturity and mechanical properties. The availability of this tool will advance the personalized medicine aspect of stem cell-based tissue formation while providing new insight into dynamic tissue development.

Statement of Benefit to California:

The aging population of California, 20% of whom will be over 65 in 2025, will require functional replacement tissues to maintain their quality of life. The promise of using stem cells to generate individualized grafts suffers from donor variability that is unpredictable and immeasurable without destructive techniques. The development of a nondestructive, minimally invasive tool enabling the dynamic assessment of tissue maturation and remodeling would provide users unparalleled insight without destructive biopsies. Herein, we aim to develop a multi-modal imaging probe that uses light and sound to measure the maturity of stem cell-generated bone and cartilage by detecting unique signatures of extracellular matrix components and observing matrix deposition. After optimizing the probe for these tissues, we will characterize maturation of engineered tissues in vitro and after implantation. This tool will reduce the number of cells required to create tissues by eliminating destructive biopsies and provide an individualized tissue product to maximize clinical outcome, resulting in reduced healthcare costs. The technology will be invaluable to clinicians and biotechnology companies pursuing regenerative medicine in California. Finally, the exposure of trainees to new stem cell-related research may provide the greatest benefit to California by inspiring future scientists to pursue their research efforts within the state or develop therapies at California-based companies.